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ANNUAL REPORT BY VICE-PRESIDENT,

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If the poet finds retrospection one of the delights of the mind, the investigator finds it to be a useful mental process at certain stages in order the better to determine not only the results certainly attained but also the methods and directions promising most in the future. Such a retrospective study has not infrequently been more valuable to the scientist than would an uninterrupted continuance of his investigations involving double the effort.

The object of these annual reports is to give yearly, for the benefit of the Society, a retrospective glance to appropriate branches of physical sciences or physical research.

I have said physical "research" as well as science, for only the enthusiastic yet class my subject—meteorology—as a science, certainly no one as an exact science. It is of course a matter of opinion as to when the epoch arrives wherein any distinct department of nature can be properly designated as a science, and as being no longer an immense aggregation of facts, theories and assumptions. Within the century the world has seen chemistry, mineralogy, botany, zoology and other now recognized sciences emerge from their previously uncertain and indefinite

status. Of meteorology, however, using this term as especially applying to weather and not to climate, which will be referred to later, it may fairly be said that the generalizations are too indefinite in terms and too scanty in number, the ascertained and acknowledged facts too insufficient as well as too disjointed in their relations, to form the indispensable work of fundamental principles whereon is to be woven the regular, graceful curves which nature ever presents to us under the magic wand as waved by the specialist in any science.

The term "science" carries with it in a degree the idea of prevision, so that exemplifications of its principles shall always find expression in foreseen results, whose ultimate variations should not exceed certain narrow limits.

Abercrombie and the writer have published, almost simultaneously, the latest works in English on the weather. My own opinions as to the status of this department of nature were clearly put in "American Weather," 1888. To quote:

"All skilled meteorologists realize how comparatively local are weather conditions and how impossible it is, at times, to make predictions for a definite period with any feeling of certainty. * * * It is evident that fair-weather conditions are those which are most persistent [i. e., they partake more of climatic conditions than of weather] and from the prediction of which the highest percentages of accuracy will be obtained."

Professor Marvin, a careful, conscientious official, whose duty has included the examination and verification of forecasts, after three years of study, says (referring to verification-percentages not being strictly comparable) in confirmation: "The reasons for this are principally because of the much greater difficulty of successfully forecasting rainy and unsettled than fair weather, together with the seasonal spasmodic variations in their respective occurrences." His illustrations make clear what has been believed by all close observers, namely, that high percentages and satisfactory forecasts are attendant on the persistency of climatic or permanent conditions (such as no summer rain in California) when unbroken by the violent and marked changes which distinguish weather from climate.

It is safe to say that the percentage of successful forecasts of rain twenty-four hours in advance is not one-half, and probably not more than one-third, so successful as forecasts of fine, clear weather for the same period.

The scientific investigator or student who longest applied himself to the study of American weather endeavored a few years since to deduce a practical rule for weather forecasts which might be applied to current and daily work. It is significant that no single application of this rule or theory has ever been made. If the test had been made it is to be feared that the criticism of Strachey would recur, viz, that theory finds not its counterpart in actual values.

It may or may not be indicative of the state of meteorology that the eleven rules for practical predictions laid down by me in "American Weather" in 1888 have received no accretions. Many are willing to indulge in criticism and glittering generalities, but in any scientific work practical and particular applications are demanded. Careful and continued observations have indeed determined the usual paths of storms, but most uncertain and so far indeterminate have been all researches to so determine the cause of storm development and movement that from observed meteorological phenomena can be seen not only the certainty of the storm's approach but also its particular course.

What do experts abroad think? Abercrombie says: "The service of weather forecasting can never be treated mathematically * * * Many isolated principles have been discovered, but no attempt has been made to lay down the broad principles of the science of the weather as a whole." The terse dictum that "The successive 'changes in the *shape* of isobars * * * indicate the sequence of weather' in any place" is declared to be the fundamental principle of all synoptic meteorology, and we have only to work out the local details connected with the changes of isobars to formulate and connect therewith sequent and appertaining weather changes.

It may well be questioned if any meteorological expert outside of the British office accepts this principle or limitation of Abercrombie's. Statistical methods, he goes on to remark, are practically devoid of physical significance, and through misuse have tended to bring modern meteorology into disrepute. While most meteorologists agree with him in their disapproval of certain statistical methods as applicable to meteorology, yet they endorse others, these or those according to circumstances, as valuable or invaluable aids to successful work in weather forecasting.

Among investigators following statistical methods is M Teis-

serence de Bort, the very able assistant of Professor Mascart in France, who believes that the recurring weather changes can be reduced to types, and who has devoted his perspicacity, talents and industry to the solution of the problem for France in particular and Europe in general.

While perhaps no scientist of high standing now invokes the moon's phases as potent factors in weather changes, yet the influence of atmospheric electricity is believed by some to possibly dominate the weather, while again others turn to terrestrial or interplanetary magnetism as the essential basis.

Not a few distinguished physicists refer the whole question directly to the radiative energy of the sun, which all, however, necessarily admit as an ultimate and predominating cause. When, however, we come to particularly apply the principle, a distinguished English astronomer claimed that the rainfall of India (which may be said to be the weather of that country) follows in its phases the curve of sunspots. Immediately the meteorological reporter, Mr. Blanford, proved that not only was this not true of the locality directly referred to, but that in India there was no year in which extended areas of country did not present striking contrasts as to precipitation, excesses in some provinces and marked deficiencies in others.

It is significant that in an article of 45 pages in the Encyclopædia Britannica, Buchan gives no law for any meteorological phenomena, and says, referring to the formulas of Ferrel, Mohn, Hann, Everett and others, that in "The development of the law of the relation of the wind's velocity to the barometric gradients," the evident inexactness of the various investigations justify Strachan's criticism that "The theoretical values do not accord with the actual values."

Delauney, in announcing a new theory of storms, says that meteorology has not yet emerged from the domain of observation, is now unprogressive, and, in fact, under present methods has reached its limits as a science. Further progress is only possible by ascertaining the causes of meteorological disturbances and in defining the fixed laws which bring about weather changes. Similar opinions could be drawn from other authorities if time and space permittted.

When the duties of forecasting storms devolved by Congressional joint resolution of February 9, 1870, on the War department, its success was by many considered most doubtful, espe-

cially in view of the fact that the efforts of Admiral Fitz Roy in Great Britain had resulted so unsatisfactorily. The problem was to evolve out of unknown and unsatisfactory conditions a system suited to America, or in other words, a system that should ensure to citizens and tax-payers practical results commensurate with expenditures. How the system of weather forecasting was built up in detail, it is neither the province nor purpose of this report to consider. It is, however, not a theory but a fact that under the military administration this service throve wonderfully; though be it understood the military administration is no more indorsed in all its details than is the civilian administration of governmental bureaus in all its details. Bickerings, jealousies, repressions, maladministration and inefficiency are not necessary characteristics of either civilian or military methods, nor can either be absolutely free therefrom. In short, in every bureau the ability, application, energy and all the commonsense characteristics of its chief, be they great or little, find their exaggerated reflex in the work done and the policy followed, in the working out of details and in the accomplishment of results.

The Weather bureau of the United States, however, soon speedily attained a degree of efficiency and success sufficient to commend it not only to the practical American citizen, but yet more to the admiring judgment of foreign scientists, who, inspired by the satisfactory work in the United States, speedily increased the scope of their own duties or persuaded the government to initiate a like system for their own country.

The conference of European meteorologists at Leipsic in 1872 resulted in a national congress at Vienna in 1873; and in an official invitation extended to the government of the United States to take part, it is said—"The wonderful results which have been obtained by meteorological observations on this continent [the United States] renders its participation in the aforesaid congress highly desirable;" and the hope is expressed that this government will, "In the interests of science and the general welfare, unite through its representatives at this congress the experience of its meteorological institutes to the observations of the meteorologists of Europe."

The Universal exhibition at Prussia in 1876, in considering the Signal service exhibit, acknowledged in express terms that no award within the power of the committee would adequately

express its appreciation of the merits of the Signal service meteorological exhibit, and consequently sent a special letter. A diploma of honor, the highest award granted, was received from the National exhibition of electricity at Paris; and a letter of distinction, also the highest award, came from the Geographical exhibition congress at Vienna, Austria, for tri-daily weather charts.

Some Americans may deprecate the strong language used in these resolutions, but it should be borne in mind that distance is necessary to give a just perspective to all great undertakings. If it be considered that no nation can justly estimate the tenor and effect, either of its ordinary and average contributions to modern progress or of its greatest achievements, so a just opinion of the ability displayed in the management of any service, or of the results obtained, can rarely, if ever, be given by the scientists of that country. Their mental vision is liable to distortion, perhaps through indifference to or distaste for the work in question; perhaps by a sense of present or fear of possible encroachment on their own lines of research; perhaps by a feeling of scientific jealously, either personal to the staff concerned or general as to the branch of natural science under inquiry. One does not have to go out of the city of Washington to hear disparaging and unprofessional reflections on the scientific standing of persons, the highest in the opinion of the world in their specialties; and as with men, so with bureaus.

Be this as it may, the Weather bureau under military administration has made its indelible impression upon the meteorological societies of all civilized countries from year to year; and even in countries where a lurking suspicion of jealously toward the growing scientific importance of the United States has existed, in these countries as in all others the means and methods employed in the United States are being followed.

It was interesting at the late conference of meteorological chiefs in September, 1891, at Munich, Bavaria, to note from time to time that the military Weather bureau of the United States had been the only office which had endeavored to live up to the scientific meteorological ideals elaborated and endorsed by previous conferences and congresses. Similarly it may be mentioned that the same peculiarity developed at the International polar congress, wherein it appears that the United States,

through the Signal service, was the only country which had endeavored to follow the line of obligation agreed on for international use in publication.

If for no other reason, meteorology owes its debt of gratitude to an officer of the army, the late General Myer, from whose mind in August, 1873, proceeded the idea of an exchange of international telegraphic weather reports as widely as possible, and to whose initiative in connection with the congress at Vienna is due the unparalleled, important and successful international meteorological work.

During thirteen years, 1875 to 1887 inclusive, the land observations of this service covered the countries of almost the entire northern hemisphere and a part of the southern hemisphere, and reports were also received from regular naval and merchant marine vessels of the principal countries of the northern hemisphere. More than 150,000 monthly reports, representing upwards of 5,000,000 daily simultaneous observations, were received, collected, and published or charted by the Signal office. The number of vessel reports reached 600, and the foreign land stations increased to a total of 459, exclusive of the international polar stations. The following countries coöperated during a part or a whole of the period 1875 to 1887: Algeria, Australia, Austria-Hungary, Belgium, Brazil, Great Britain, Canada, Cape Colony, Chili, China, Costa Rica, Denmark, Egypt, France, Germany, Greece, Hawaiian islands, India, Italy, Japan, Mauritius, Mexico, the Netherlands, Norway, Russia, Scotland, Spain, Sweden, Switzerland, Turkey. In addition to the reports furnished by the regular services of the several countries, observations were made and forwarded from the islands of the northern Atlantic ocean, of Central America and northern South America, and from Bering island, the Aleutian islands, Alaska, Greenland and Iceland.

The international publications of the Signal service, which commenced with the regular issue of the daily bulletin of simultaneous observations in July, 1875, embodied data whose value cannot be overestimated. The network of stations which covered the northern hemisphere for a period of years furnished a vast number of reliable observations, the study of which has in no small measure contributed to recent discoveries and advances in meteorology, and in future investigations these observations will be invaluable.

These publications and charts are based upon an unparalleled series of observations; they represent graphically the labor of meteorologists throughout the civilized world for a period of thirteen years; they are unique in the annals of meteorology; and their proper presentation, rendered impracticable heretofore owing to insufficiency of funds, is alone needed to class them with the most treasured products of modern meteorology. In completing this work, the Signal office has compiled maps showing the mean pressure of the northern hemisphere as deduced from ten years observations under this system, and the changes in pressure from month to month; and it has also charted the average storm frequency for each month of the year.

In considering these great labors, one may be named who is no longer sensitive to criticism, the late General Albert J. Myer, whose diplomatic skill and wonderful persistency in dealing with the legislative branch of the government and whose judgment in selecting his subordinates ensured ultimately both a financial support for the service in general, and also an excellence of execution in general weather predictions and in detailed work throughout the country which have never been attained by any other meteorological service in the world. Then theoretically equal credit is due to the late Professor Ferrel, whose relations were maintained with the Signal service until he sought his well earned retirement, and from whose intelligent ability and aptitude for research have proceeded the most complete and satisfactory treatises on meteorology from a scientific and mathematical standpoint. The important services rendered by other distinguished professors merit similar praise.

As to the officers and professors forming the general staff of the bureau, it may be remarked that their labors in organizing, developing and operating the meteorological work of this service will never be adequately stated or generally recognized. It is, however, a matter of record that the meteorological system devised by officers of the United States army has proved to be the most successful practical service in the world, and has served as a working model and example for other nations, while its unique exhibits have elicited unparalleled commendation. The records of such officers as have participated in the work of this service for any prolonged period show the native ability and special adaptitude of army officers, when ordered to scientific duty for which they had not been educated and which more than one

accepted with reluctance, and proves, if proof were needed, that the holding of a commission does not emasculate intellectual qualities.

As to the Signal service in general, it collects and distributes an enormous amount of weather data. In accuracy of collation, in speed of collection from and distribution to distant points, in extent and in legibility even of its ephemeral publications, the service is not only unrivaled, but is not even approached by any other weather service in the world. In attaining this practical excellence, many peculiar methods of work and a large number of special mechanical devices were essential to the present success, and in this connection the intelligent ability and interest of the enlisted men who served as observers is evidenced by the fact that far the greater part of these improvements in mechanical details and office methods is due to ideas, suggestions, etc, therefrom. The local observers in charge of stations throughout the country have, almost without exception, obtained their entire knowledge of weather predictions and their meteorological information while in this service. More than one-third of the observers in charge of stations have had the benefit of some collegiate training, and the satisfaction of observers with their status is evinced by the fact that their average length of service has been 13 years, while the entire life of the service has only been 20 years. Only a small percentage of the observers have left the Signal service save to benefit themselves by accepting duties of a more responsible and better compensated character, which often have opened up to them through their connection with the Signal service.

The military staff of the Signal service has all these years worked under the greatest possible disadvantages, receiving no additional pay for the performance of weather duty. Their professional standing in the army often suffered from their absence from their corps, and they received scant acknowledgment and honor from other sources. This, too, while serving on such a pay and under such conditions in a large city as to prevent officers from living in accord with their brother officers serving with their regiment or corps. More than one hundred officers have been detailed for signal duty, but not more than a dozen have ever been willing to remain for any length of time, and the number of these was subject to change and depletion by promotion, resignation, or the assumption of better paid duties bringing profes-

sional and personal reputation. In other words, the Signal service staff has been poorly compensated, either in money or reputation, has had no definite status, and has worked merely for the love of science, which is indeed the most beautiful and stimulating sentiment animating men of science, but which alone and unsupported, as is well known, does not always lead to the best results either in theoretical or in applied sciences.

As regards detailed studies and scientific theses, it may be well admitted that the meteorologists of other lands have contributed more fully to the literature of the day than the meteorologists of the Signal service, but it should be borne in mind that eight years ago a Congressional commission reported against the continuance of scientific investigations previously fostered by the Signal service, and a clause in an appropriation bill compelled the abandonment of the school of instruction and the discontinuance of theoretical meteorological research, except incidentally. As to the regular publications, reference elsewhere shows that the unequaled Weather Review of the Signal service has been imitated abroad, and as to the more ephemereal publications, it may be pointed out that the example of the Signal service has also been followed out as to daily weather maps and accompanying meteorological data.

In Australasia, by the combined efforts of several states, there is issued each day a weather map; in Belgium, one map is issued; in Austria-Hungary, one; in Algeria, one; in France, one; in Japan, three; in India, one; in Russia, one; and in Switzerland, one.

The intellectual activity of the staff of the Weather bureau may be indicated by the fact that more than four hundred separate articles were mentioned by title in the report of the Chief Signal officer for this year as having emanated from these officials during their connection with the Signal service. Far the greater number pertain directly to meteorological subjects, and a majority of them have been printed without expense to the government.

There has been assertion on the part of ill informed persons that proper attention has not been given under army administration to the collection and discussion of climatic data. As an answer to this, it is only necessary to point to the monthly Weather Review initiated in 1873, which is, and always has been,

the most complete repository of climatic data in the world. This publication, for eighteen years, has presented both in tabular and graphic form the salient climatic conditions of the United States so far as could be determined. From a folder the size of ordinary letter paper, with only 37 lines of text and one chart, it has grown to be a large, well printed quarto, averaging 28 pages to the month and having 50 charts annually.

The Review from the very first was largely climatic, two-thirds of the earliest numbers being given to temperature and rainfall, and gradually this proportion in regard to climatic data and discussion has increased until it amounts at length to fully three-fourths.

The single chart of storm-tracks was speedily followed by two others, on which were respectively represented for the United States (1) the monthly rainfall, and (2) the isobars, isotherms and prevailing winds for the individual month. Other appropriate charts have likewise been reproduced, such as mean depth of snowfall, the amount of snow on the ground in the middle or at the end of month, the range of temperature, the movements of high areas, the departures of temperature from the normal, the distribution of thunder-storms in the United States and Canada, etc; and also charts indicating the limits of dangerous ice in the northern Atlantic, and international charts for the northern hemisphere, showing for the month the mean pressure and the mean temperature and prevailing winds at the hour (Greenwich noon) of simultaneous observations. Similar maps for the yearly means have also been issued for Canada and for the United States and the northern hemisphere.

From occasional and widely separated data as to wind, temperature and rainfall on chart or in text of the first Review, the present publication includes observations and means from observers as to maxima temperatures, minima temperatures, mean temperatures and rainfall for each month, exceeding 2,000 in number in the United States; and other data from about 500 more stations in Canada and along the sea-coast of North America have also been discussed, thus making over 2,500 separate monthly reports as to climatic conditions made available in such manner that "he who runs may read."

This summary conveys no adequate idea of the variety and character of the immense and valuable masses of climatic data which the monthly Weather Review of the Signal service has

scattered over the world relative to, and in the interest of, the United States.

The great value set on this publication both by skilled meteorologists and by the reading public of this and other countries has been a source of astonishment and gratification to other chiefs and to myself.

As to the opinion of the distinguished meteorologists abroad, recalling the saying that imitation is the sincerest form of flattery, it is to be remarked that monthly publications similar in literary form and substance have been instituted in Canada, Germany, Great Britain, India, Jamaica, Mexico and Victoria.

Among other valuable compilations and graphic representations of climatic data for the United States in general published by the Signal service may be mentioned:

1. Isothermal charts for each month of the year, based (*a*) on observations of ten years, and also (*b*) on observations of eighteen years.

2. Charts of normal temperature at 8 a. m. and 8 p. m. for each decade in the year.

3. Charts of absolute maxima and minima in each decade and also for each year at all Signal service stations (awaiting press).

4. Charts of isotherms and isobars and prevailing winds for each month from January, 1871, to 1873, inclusive.

5. Tables indicating diurnal fluctuations of temperature for each hour and month at 47 typical and representative stations.

6. Charts and tables of average dates of first killing frosts of autumn and last killing frosts of spring.

7. Charts and tables showing the normal rainfall for each month based on record (*a*) of 10 years; (*b*) of 18 years; (*c*) of 20 years (May and June; rest awaiting publication).

8. Charts and tables showing the rainfall for each month from January, 1870, to December, 1873.

9. Excessive precipitation for month, day and hour at all available stations from establishment to 1890.

10. Charts for each month, showing the probability of rain at all Signal service stations as deduced from 18 years' observations.

11. Charts and tables of possible annual evaporation.

12. Charts of average cloudiness for each month of the year.

13. Charts of most frequent wind-direction and average hourly velocities at 65 typical and representative stations at 8 a. m. and 8 p. m.

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14. Hourly wind travel at principal and representative stations, 1881–1890.

15. Tables showing the diurnal fluctuations and pressure of the atmosphere for each hour of the day and month of the year at 29 representative stations.

16. Charts with tables of supporting data from 654 separate stations, showing for Arizona, California, Colorado, Idaho, Indian Territory, Nevada, Oregon, New Mexico, Utah and Washington state the average precipitation and the greatest and least quantity of rain for each month of the year.

17. Climatic charts and tabular matter, with discussion relative to temperature, rainfall, sunshine, frost, evaporation, etc, of the states of Nebraska, Oregon, Texas and Washington.

18. Climatic charts, diagrams and tables from 651 stations relative to irrigation and water-storage in Arizona, California, Colorado, Nevada, New Mexico and Utah.

Many other similar climatic publications of less extent and importance might be added; but reference will only be made to the chart of rainfall and temperature for Michigan, and several charts of normal temperature for New York, both prepared at the office of the Chief Signal officer.

The annual reports of the Chief Signal officer have been largely given up to climatic data, which for years were published on so liberal a scale as to induce criticism from members of Congress. For several years the amount of climatic data annually published exceeded five hundred octavo pages, and for the past eighteen years has averaged over three hundred octavo pages.

The climatic work of the Signal service of the army can be summarized by the general statement (which can be verified by any one who wishes) that the climatic characteristics of the United States have been determined and are better known than those of any other equal area on the surface of the earth.

The forecasting of weather was not the only duty imposed by law on the office. The construction, maintenance and operation of about 5,000 miles of telegraph lines on the Indian and Mexican frontiers and along the uninhabited coasts of the Atlantic and Pacific oceans, the performance of military signaling duty, the gauging of the principal rivers of the country and

the predicting of floods and low waters therein, have also demanded special application, ability and energy which could not but somewhat impair the interest in the weather work and detract from the success with which it was prosecuted. The high degree of success in these other branches has been recognized by those interested in the practical work involved therein. The accuracy of river and flood forecasts and the ample notice thereof in advance have elicited well deserved encomiums from the inhabitants of the valleys of our great rivers, and the rules for flood forecasts have been laid down with most satisfactory results.

It is not the intent to convey an idea that no further progress in these various branches of work is possible, for knowledge ever goes on from more to more, and improvement is the order of the day.

The spirit toward other scientific branches of investigation, if not so catholic as extremists could wish, has been so liberal as to compare favorably with that of any other governmental bureau. Few realize how difficult it is for any bureau chief to obtain from the legislative branch of the government sufficient appropriations for the liberal support of the special duties of his bureau, but the difficulty is greatly enhanced when it is sought to obtain funds for contingent purposes involving the carrying on or the investigating of subjects relating indefinitely, if indeed at all, to the more specific duties of the bureau. Again, instances are not rare in which individuals or institutions desire to obtain the aid of governmental bureaus in the investigation and support of matters which, although worthy in themselves of encouragement and aid, in their nature partake rather of private and personal schemes than of the more general investigations for the public benefit. In short, it rarely occurs that means and sense of duty permit the diversion of large sums from the narrow scope of official action imposed on a bureau by the limiting provisions of appropriation acts and the perhaps more important restrictions of the auditing officials of the treasury.

Considering limitations of law, restrictions of auditors, and amounts of appropriations, the Signal service has shown great liberality in extending aid to collateral investigations and researches. It has spent for such purposes not simply hundreds or thousands of dollars, but tens of thousands. Among other noteworthy instances involving important or essential aid may

be mentioned International meteorology, Langley's magnificent and unique work at mount Whitney, the contributory observations for the Fish commission, demanding special instruments and sometimes extra observers; extensive and, as Professor Baird said, "indispensable aid during this transition period" in ethnological and other work throughout the extent of all Alaska; coöperation with the Polaris expedition; the Cumberland sound work; the solar total eclipse of 1878; the investigation of the locust plague; the point Barrow and Lady Franklin bay expeditions, which otherwise could never have started; the Labrador expedition; the Death valley investigations; and the western Africa eclipse expedition.

It should be borne in mind that the civilian organization now in operation is due entirely to the military force. The lately lauded system of local forecast officials at the more important cities is simply a continuation of duties initiated several years since, and which, as to name, compensation and scope of work, were planned and carried into execution by officers of the army.

The estimates and proposals for liberal pay to civilians in the reorganized Weather bureau were also the work of an officer, and the pay obtained was not only considered exceedingly liberal by the legislative branch but also by the civilian organization, as evinced by the omission of two professors of highest pay from the estimates of this year.

En résumé, it has been shown that the Signal corps of the United States army has so conducted the meteorological work entrusted to its charge as to develop and advance meteorological investigation to very near the dignity of a science, partly through the high class of work done by the service and partly by the stimulus it has given to this work through its international system and other liberal methods; that the practical application of weather forecasts has attained a degree of perfection unexcelled, if even equalled, by any other nation; that its system of river observations and flood forecasts, taking into consideration the enormous area of the drainage basins and the unparalleled amount of material interests concerned, has reached a stage comparing most favorably with that of any foreign country; and that the graphic and tabular data representing the climatic elements of precipitation, temperature, wind, sunshine, evaporation, humidity, prevalence of cloudiness and probability of rain, have

covered the entire United States with a fullness and perfection of detail unknown over any other equally extensive area on the face of the globe.

It is believed that no branch of meteorological or climatic investigation has been neglected by the army administration of the Weather bureau, and the character and reliability of the work thus done is submitted with confidence that it will stand the test of investigation and discussion as well as that of any other department of natural science through a period of equal length in its organization, development and transition upwards.

One broad field opens up to the Weather bureau under its happy organization, freed from the heavy burden of conflicting duties foreign to scientific work, and in this field of the relation of weather and climate to agricultural productions the prospects for great usefulness is possible. This field the army administration made unavailing efforts to cover through coöperation with the department of agriculture, but to a bureau of its own this department will no longer maintain an indifferent attitude such as was displayed toward the army.

In its development in this and in all directions, and in the efforts of its professors and advocates to place meteorology among the acknowledged and exact sciences, the United States Weather bureau has no more interested or friendly sympathizers than the officers of the army who have contributed by their labors to the perfection of the splendid, practical system on which this bureau now rests.